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Invited editorial

Cardiothoracic surgical critical care: Principles, goals and direction☆

"Progress lies not in enhancing what is, but in advancing toward what will be" —— Khalil Gibran

1. Introduction

Until the late 19th century, Cardiothoracic Surgery did not exist. Surgeons were warned against operating on intrathoracic organs. Dr. Billroth reportedly proclaiming that 'Any surgeon who attempts operating on the heart should lose the respect of his colleagues' and the admonition by Dr. Ernest Dieffenbach to "stop at the pleura" illustrate the prevailing belief that to open the chest was to kill the patient. Pioneered by a few surgeons directly suturing the heart wounds, around the turn of the century, thoracic surgery was seen as the surgical treatment of "lung abscess, bronchiectasis, empyema, and chest wall tumors" and thus lacking enough foundation to launch a new Society (the American Association for Thoracic Surgery)[1,2]

Operations directly involving the heart and great vessels did not begin until the 1940s, with procedures to palliate congenital cardiac defects, such as the "Blue Baby" surgery by Dr Blalock, and closed mitral commissurotomy in 1948. The invention of the heart-lung machine in the early 1950s has revolutionized the field allowing robust, trailblazing innovation by such pioneers as Drs. Lillehei, Kirklin, DeBakey, Cooley and Shumway to develop novel procedures to definitively address structural and functional anomalies of the cardiovascular system; under direct vision and in a clear, quiet and bloodless field.[3,4]

This rapidly growing new surgical discipline necessitated the development of an equally new way to manage these patients during their perioperative period. Dr. Albert Starr was among the first surgeons to lead an interdisciplinary team of "cardiologists, anesthesiologists, nephrologists, hematologists, neurologists, and even a psychiatrist". He also saw the need to establish the first dedicated cardiac surgery intensive care unit for the management of these patients.[5]

2. Basics and goals of cardiothoracic surgical critical care

The foresight of Dr Starr in establishing a dedicated team and an intensive care unit for perioperative care of cardiac surgical patients highlights the unique nature of management of these patients and the features distinguishing this area of practice from other Critical Care environments. Over five decades of CT surgery, a multitude of new procedures, and devices emerged, and clinical and basic science knowledge has expanded, emphasizing the growing need for knowledgeable, skilled surgeon leaders with specialized training, well-versed in the intricacies of this particular area of surgical practice.

Cardiothoracic Surgical Critical Care generally addresses subacute, indolent and chronic conditions, almost always the result of a disturbance in the patient's homeostatic mechanism. Level of acuity of patients is considerably variable: About half of the patients are managed along the "Fast Track" pathway of recovery, expected to the ICU within 24 h of admission, with approximately 35% of patients requiring minor adjustments before transfer. Only 10–15% of patients remain in critical condition for longer than 36–48 h.

In addition, the pre-operative pathologic anatomy and physiology are of paramount importance, being the indication for surgical intervention. Also of critical importance is the impact of the surgical procedure on the multi-organ interaction, which –in turn- affects postoperative expectations and complications. The cardiac unit is always understood to be two pumps in series, with the pulmonary unit integrated in the circuit. The use of cardiopulmonary bypass is routine.

CTSCC management aims to correct or ameliorate cardiac and/or pulmonary dysfunction, as well as stabilization of other organ systems affected by it.

However, Surgical Critical Care and other areas of Critical Care do share several aspects, such as addressing the systemic response to injury, the decreased immune response and an increased risk of infection, disturbances of coagulation and bleeding and pulmonary complications such as Acute Lung Injury. Most importantly, a systems management approach to the critically ill patient is standard.

3. Cardiothoracic surgical critical care as a distinct specialty

Several reports have demonstrated the benefit in clinical outcomes when clinicians with experience specific to the CTS practice assume a leadership role in managing the multi-disciplinary team of the CTS intensive care unit.[6–10]

In its publication "Thoracic Surgery News" in November/December of 2008, the American Board of Thoracic Surgery announced that it "recognizes that cardiothoracic critical care has a set of skills and a knowledge base that are not covered by the critical care certificates that currently exist in other specialties" and thus adopted a resolution "to seek to establish a separate certificate in cardiothoracic critical care, and to greatly enhance the teaching of cardiothoracic critical care at the resident and postgraduate level".[11]

This recognition by the parent organization of CTS of CTSCC as a distinct area of clinical practice, with its unique knowledge base,

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Table 1
Principles of systems-based management in cardiothoracic surgical critical care patients.

Monitoring and diagnostics	Hemodynamic monitoring	Arterial lines Central venous catheters Swan-Ganz catheter Direct intra-cardiac lines
	Physiologic monitoring	Pulse oximetry Urinary catheter Intra-cavitary temperature probe Cerebral oximetry Trans-cranial doppler Evoked response potential sensors EKG EEG
	Imaging modalities	Radiography Trans-thoracic echocardiography/trans-esophageal echocardiography Computed tomography Magnetic resonance imaging
Systems management	Neurologic	Level of consciousness, Short-term and long-term sedation Agitation/restraints Focal deficits, mental state Psychologic/psychiatric state
	Cardiovascular	- Determinants of cardiac performance: rhythm/dysrthymia management, rate/pacing, preload/filling pressures, afterload/SVR/PVR/vasopressors/vasodilators, contractility/inotropes/chronotropes, - Tiered plan for low cardiac output syndrome, Need for MCS/IABP, ECMO/ECLS/Other MCS, - Tamponade (pericardial/sternal) - Bleeding/CT drainage/take-back/ - Open-chest situation, - Code blue/BLS/ACLS, CPS
	Vascular access	Central lines/arterial lines/SG catheter/introducers, sheaths/PICC lines
	Pulmonary	Capacity for spontaneous respiration, weaning parameters, extubation/oxygen supplement/weaning/ CPAP and BiPAP/ Pulmonary congestion/edema, Additional or long vent support: risks/precautions/re-intubation/tracheostomy, Ventilatory strategy: types/selection/management ECMO consideration/criteria/management The pleural space: air leaks/pneumothorax/pleural effusions/thoracentesis/chest tube placement
	Gastro-intestinal	Capacity for independent feeding: level of consciousness, aspiration risk, swallowing integrity Motility issues: acute gastric dilatation/constipation/ileus/obstruction/intestinal ischemia, Feeding strategy: diet types/feeding routes: NGT/PEG/TPN/PPN
	Renal	UOP/oliguria/ATN/acute renal failure, Electrolyte balance, acid-base balance, Fluid balance/diuresis Dialysis: HD/CVVHD/SLEDD/ultrafiltration
	Endocrinology	Glucose management/adrenal insufficiency/thyroid replacement/other issues
	Infection control	Prophylaxis, surveillance: sterility/infection precautions/catheter and lines/cultures Therapeutic: empiric/culture-guided Resistance/isolation: MRSA, VRE, neutropenic
	Hematology	Coagulopathy, DIC, transfusion strategy Hypercoagulable state HIT, HITT, Coumadin, alternate anticoagulation
Preventive measures	DVT prophylaxis, VAP prophylaxis, Decubitus prophylaxis, CTS critical care fall precautions, Ulcer/GI bleeding prophylaxis Bleeding precautions Wound care	
Ethical and social issues	Decision making, spokesperson, living will/advance directives, Code status, DNR tiers and options, end-of-life issues Quality of life,	
Process issues	Science of safety Error causation and prevention Teamwork and leadership	

skill set and clinical judgment has earned the endorsement and sponsorship of educational activities specific to CTSCC issues, as has been spearheaded by the pioneer organization Foundation for the Advancement of Cardiothoracic Surgical Critical Care (FACTS-Care) since 2004. [Nevin Katz, MD. Personal communication. May 2011]. It has also given strong momentum to promote a new class of clinicians, the CTSCC surgeons, to assume a leadership role in the multi-disciplinary management of CTS surgical patients.

The principles of cardiothoracic surgical management are:

- Correction of anatomic abnormalities
- Amelioration of functional abnormalities
- Replacement of the failing organ

Therefore, the principles of Cardiothoracic Surgical Critical Care management can be summarized in the following:

1. Initial recovery from surgery:
2. Maintaining a Stable/Optimal native cardiovascular and/or pulmonary system performance:
3. Stabilization/optimization of other major systems:
4. Promoting independence from invasive measures and Preparation for rehabilitation.
5. Prevention and Management of Complications.

As such, it is imperative that the clinician in a leadership position in CTSCC be well-versed in the pre-operative anatomy and physiology of these organ systems, as well as the operative and technical details of the surgical intervention, its planned goals and its implications in the postoperative period. Because of their specific knowledge, skills and training, only CT surgeons are uniquely qualified to be in such leadership role. In addition, a comprehensive understanding of the intricate inter-dependence of multiple organ systems and their function within the context of cardiopulmonary dysfunction is paramount for assuming a leadership position in a multi-disciplinary team in the CTSCC environment. Table 1 illustrates the basics of such a comprehensive management strategy.

4. Issues and challenges

The responsibility for managing CTS patients in academic centers is usually that of the residents and fellows in CT surgery or its disciplines such as Heart Failure/Transplant or Congenital cardiac surgery. Because of the limitations on resident work hours, as well as the decreasing number of applicants for surgery in general and CT Surgery in particular, “visiting fellows” and “clinical associates” as well as general surgery residents often participate in managing these patients. Moreover, this coverage is always a temporary assignment, since these surgeons will leave the program to continue their careers as attending. Very few of them are interested in a career as an “intensivist” with no operative duties. In non-academic centers, this responsibility is shouldered by the attending surgeon in most cases, with general Critical Care specialists (“Intensivists”) providing substantial coverage in the intensive care units. Nurse practitioners and physician assistants often contribute to the effort. This paucity of specialty-specific trained surgeons is further compounded by the great variation in the experience of those physicians currently in charge of CTSCC due to the paucity of uniform, specialty-specific practice guidelines. This negatively impacts communication and teamwork, leading to an inefficient clinical management process with suboptimal outcomes.[12–16]

5. Future directions

Cardiothoracic Surgical Critical Care has emerged as a distinct, evolving sub-specialty to address the unique issues specific to the management of patients who undergo surgical treatment for cardiac, thoracic, or pulmonary conditions within a critical care environment.[17,18] The ABTS is developing educational, training, certification and credentialing pathways for this emerging specialty. [Valerie Rusch, MD. Personal communication. May 2011].

This emerging new sub-specialty has been supported and sponsored by its natural parent organizations (the American Association for Thoracic Surgery, the Society of Thoracic Surgeons and the American Board of Thoracic Surgery) endorsing its educational activities as well as its ‘birth mother’, the Foundation for the Advancement of Cardiothoracic Surgical Critical Care.

The goals of these organizations as well as pioneers of this specialty are to:

- Improve the attractiveness of the specialty to surgeons in training as well as in practice to eventually achieve a “Critical Mass” of applicants which will provide the new specialty with its much-needed broad-based support.
- Strive towards the independence from general Critical Care connections, and instead develop independent, specialty-specific, evidence-based Practice Guidelines and Consensus Statements based on the real-world, CTS population based data. (Nevin Katz, MD. Personal communication, September 2010)
- Expand the specialty to include other clinicians such as critical care nurses, nurse practitioners and physician assistants, as the specialty matures into a true multi-disciplinary, multi-level team based practice. (Jill Ley, RN, MS, CNS; Denese Sabatino, APN, CCRN. Personal communication, July–August 2010)
- And finally, to continue to shape and improve the impact on the regulatory organizations with regard to recommendations for recruitment, recognition and eventually compensation and reimbursement as an endeavor to increase the incentives for clinicians to choose this specialty as a career, and help reduce the ‘brain drain’ of experienced clinicians who are currently fleeing the specialty to pursue other careers, sometimes in non-surgical environments.

6. Conclusions

Nearly 100 years after the establishment of its parent organization in the US, our specialty is at a crucial crossroad. The societal, demographic, scientific and technologic advances in cardiothoracic surgery, with the emergence of novel areas of knowledge and practice, demand that the specialty evolves to meet and surpass these challenges. The creation, nurturing and support for emerging and evolving sub-specialties to address these new challenges remains the only way to guarantee survival in the new era. This support must be based on solid scientific foundation, be in tune with the current developments and trends in medical and non-medical knowledge and practice and appealing to the new generations of professionals who will continue to be leaders of innovation and progress, and ultimately shape the future of the specialty.[19–21]

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Hisham M.F. Sherif – study design, data collection, data analysis and writing have all been performed by myself.

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